pendens 2–5 cm. Flos pendens. Sepala lanceolata, 2.0–2.5 cm long.; petala lanceolata, 2.0–2.5 cm long., 6–8 mm lat., alba, ad marginem viridula. Antherae 5–6 mm, purpureo-roseae.

Newfoundland: *I. J. Bassett 293*, west coast, near Stephenville, west side of E. Harmon Air Force Base, in wet black soil under alder brushes, June 9, 1949 (DAO, type); *I. J. Bassett 269*, eodem, June 4, 1949 (DAO); *Smith, Smith & Squires 346*, Bonavista North, "The Beaches," Brown's Beach, rich woods near beach, July 26, 1946 (DAO).

TRILLIUM ERECTUM L. f. **sessiloides** f. n. Flore sessili.

Ontario, Carleton: Beechwood, close to the cemetery gate, May 1899 (DAO, type).—Bernard Boivin, Department of Agriculture, Ottawa, Canada.

THE REPOPULATION OF INTERTIDAL TRANSECTS[1]

Elizabeth M. Fahey[2]

When bare transects are exposed in the intertidal area, populations occupy them (Fahey & Doty, 1949) until after a time they look like the surrounding "control" areas. In quest of information concerning the actual sequence leading to "climax" associations a detailed study was undertaken at Nobska Point and Woods Hole, Massachusetts. The work was initiated in July, 1947, and is still incomplete. However, since the investigation has been carried on continuously from that time it is hoped that these observations may prove of interest to the marine ecologist and be of value to future workers in the field.

A review of the literature concerning intertidal ecology presents the field worker with many enigmatic ecological problems. In comparison to the extensive publications available there are but few inferences. Lack of such logical conclusions from given data, due to short-term experimentation or for other reasons, has resulted in confusion and in many cases, for example in the matter of biotic succession, this lack has given rise to more than one school of thought. In an effort to understand better what does happen in the intertidal region and why, a long-term program of repopulation studies was outlined. It was planned to clear summer, fall, winter and spring transects in order to test the hypothesis that the first macroscopic forms to appear are

[1] This report has been taken in part from a dissertation which the author submitted to the Department of Biology of Boston University in May, 1950, in partial fulfillment of the requirements for the degree of Master of Arts.

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similar, regardless of what time of the year the strip is cleared, the assumption being that the season of the year in which the transect is denuded has little effect on the cycle of reestablishment. The data recorded could then be applied to determine whether biotic succession occurs in marine associations as suggested in the conclusions of Hewatt (1937), Kitching (1937), Moore (1939), Moore & Sproston (1940) and Scheer (1945) or merely seasonal periodicity as expounded by Shelford (1930), Pieron & Huang (1925) and McDougall (1943). It was also proposed to choose stations in different positions in relation to the movement and force of the sea to observe effects on subsequent colonization. For this reason more than one transect was denuded at each time of denuding. According to the plan, observations were to be made bi-weekly throughout the year or until a complete cycle was reached and all data were to be carefully recorded.

Nobska Point, Cape Cod, Massachusetts was chosen as the site of the experiments and the region was surveyed and photographed in what was thought to be a "climax" condition. The region was then divided into transects (stations) which were designated as IA, IB, IIA, IIB, etc., and a program relative to their denudation set up. Each station was photographed before and after denuding and at low tide periods during the investigation, weather and light conditions permitting. No attempt was made to record horizontal distribution of the various associations noted. The transects were examined from the highest levels in which marine organisms were manifest to the lowest tide levels, and the vertical distribution of all macroscopic forms recorded. The vertical range was noted in centimeters above or below the mean low water datum point (the 0.0 level of tide books). Collections were taken nearly every time observations were made and identification of these herbarium materials was later carried out in the laboratory.

At Nobska Point the unusually low temperatures during the winter of 1947–48 (extremes for this section of Cape Cod) resulted in a complete ice covering over the intertidal area. This provided an excellent opportunity to witness the remarkably destructive effect of ice on the intertidal biota as well as the subsequent repopulation of the areas so denuded. All transects

cleared previously took on at this time the appearance of their immediate surroundings and were lost to view. The intertidal region was then considered to be a series of winter transects scoured of their biota by ice. The subsequent course of repopulation on all transects was similar and the same as that of the surrounding area; so observations after February 21, 1948, were largely confined to one station.

Observations over the six years this investigation has been carried on, tend to support the idea that the problem of classifying the colonizers of denuded transects in the intertidal region as undertaken by Bokenham (1938) and modified by Northcraft (1948) is really a problem of succession. Also, that the course of repopulation, insofar as it concerns any particular succession of species, is dependent on the life cycles and forms of the organisms, as well as the time of clearing in respect to the time of reproduction, particularly of the rapidly-growing longer-lived organisms. Therefore, a classification of the species, from the point of view of their succession in repopulating denuded areas, should include a consideration of growth rate, life cycles and forms and time of reproduction of the species. At Nobska Point the colonizing marine flora and fauna apparently follows a definite order. The first macroscopic forms to appear, i. e., the pioneer colonizers, seemingly vary as to species with the tides and seasons. The "pioneers" are always rapidly-growing forms. They may settle as spores or larvae either over a broad vertical area and then become more narrowly delimited or more rarely they may settle over a restricted range and spread outward. This group may be either transient forms, such as *Enteromorpha*, or persistent forms, such as *Balanus*. Next appear secondary forms which may likewise be of two types: 1) those that are a normal part of the seasonal progression for the area, and 2) those that appear after the pioneers, but which do not persist and which otherwise would not be expected to appear as dominants. Possibly among these latter are the principal "occasional algae" of other workers. Finally, as long as the environment remains uniform or changes cyclically the organisms making up the "climax" situation produce a condition characterized by a certain seasonal progression of forms or by dominants that as species, or communities, seem to reproduce or, at least, maintain

themselves. These latter climax colonizers are slowly-growing or long-lived forms either as species or as individuals.

Recolonization of the transects at Nobska Point compares well with the findings of other investigators. Transects, cleared during the summer and fall, followed a similar sequence during the course of the reestablishment of their biota. The first macroscopic organisms to occur, in all cases, were *Enteromorpha* and *Polysiphonia*. On all rocks sufficiently high, *Calothrix* was an early repopulant.

Some macroscopic forms apparently require a surface unoccupied by other species in order to achieve dominance. One of these is *Balanus* which settled in its second year only within its adult range and on areas free from all algae and older *Balanus*. That is, it was observed in places where old *Balanus* had been worn away by some environmental factor and was observed filling in the spaces between the widely scattered white *Balanus* of the previous year. Bokenham (1938) also mentions this preference of the various species for algae-free rocks. *Enteromorpha* behaved this way in part, for while on one transect it became a dominant form it appeared less so or merely appeared as scattered tufts on the adjacent *Balanus-Ralfsia* settled surfaces. It may very well be that many of the "occasional algae" of Northcraft and of Bokenham are of a similar nature, and likewise might become dominant as pioneers under some circumstances.

On the winter transects *Balanus* was the only macroscopic pioneer below the *Calothrix* zone. *Enteromorpha* failed to appear on the ice-scoured surfaces until more than two months after the *Balanus* has settled. In this case, *Enteromorpha* was not a pioneer even when only the algae are considered. The first macroscopically visible algae which appeared as a coating on the rocks and barnacles were brown algae such as *Chordaria* and *Scytosiphon*. This phenomenon may be taken as evidence that at some seasons certain components (here perhaps *Balanus*) of the complement of forms, expected as pioneers and reproducing at the time, may in some way prevent a form (here *Enteromorpha* which is often a conspicuous colonizer otherwise) from appearing in its usual role. It is possible that the reproductive bodies or juvenile forms were consumed as food by the barnacles.

As one analyzes these recolonization studies many avenues for future investigation and the tremendous amount of experimentation to be done in the field become evident. Because of the difficulties of distinguishing between tidal effects (primary and secondary factors and their chance coincidence), seasonal effects, and the differences between one season and the next (or other) seasons (or cycles, annual or otherwise) a supplementary experiment was felt necessary if biotic succession and seasonal periodicity were to be segregated satisfactorily. It has already been observed that marine organisms in repopulating denuded transects follow a certain course of events leading to the reestablishment of the original pattern of populations. The series of populations has features in common with natural phenomena of the areas already populated (control areas) and features that are unique. Observations tend to support the hypotheses that when tidal variations and seasonal periodicity are eliminated or controlled, biotic succession, when present, can be seen and that the effects of tidal action can be determined by exposing a set of transects to the tides and another to all the same features save the tides.

To test these hypotheses panels were planned for exposure. Eighty pine panels were made up alike in stock and dimensions. A piece of lead was tied to one end and plastic rope to the other end of each panel floated. This immersed the panels in an upright position with about 14 centimeters of the roped end out of water. The panels were numbered and the rope was secured to a wharf so that the panels would neither entangle nor float away. Stationary panels under the same conditions, operationally, were set out. Fisheries Wharf, Woods Hole, Massachusetts was chosen as the site of the experiments. The proximity of the Marine Biological Laboratory facilitated observation and experimentation during both the summer and winter months and offered many other advantages.

Since August 1951 panels have been exposed for overlapping periods of more than two weeks. This controls variation due to periodic fruiting of organisms on non-floating substrata or rhythmically fruiting forms which will provide the reproducing bodies that will initiate growth on these panels. Such panels kept out for a year should show a change in population through the year. If only seasonal periodicity is involved each of the

population changes observed should be of organisms capable of pioneering and should be independent of previous populations. This experiment has been outlined to run for a two year period and observations and collections are currently being made weekly. Since panels are to be exposed for one, two, three, four, six, seven, twelve and twenty-four month periods, they are set out in varying numbers monthly. When removed panels are floated in a tray, examined, photographed and all data carefully recorded. Notes on the dominant species occupying non-experimental nearby areas (pilings, wharf and wall) are taken.

The experiment was designed to run for a year but subsequent observations and complexities indicated this to be too short a time interval and it was deemed wise to continue it through a second year. At the present time the results for eighteen months have been recorded. These results indicate that biotic successions can be demonstrated in the intertidal regions of Woods Hole, Massachusetts, and these may correspond closely to those already noted by Scheer (1935) working at Newport Harbor, California. Redfield & Deevy (1952) have suggested a possible significance in the fact that a high proportion of the evidence for biotic succession comes from the Pacific Coast of North America where seasonal phenomena are less pronounced than elsewhere in the temperate zone. They conclude with the statement, "Where seasonal variations are large, biotic succession may not be obvious." On the basis of my studies I believe that biotic succession is obvious enough where seasonal variations are large but few workers make the necessary long-term observations in a region with the rigorous climatic conditions found in the New England winter.

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Color Form of Helianthus mollis.—Throughout its range ordinary *Helianthus mollis* has deep-yellow or orange-yellow rays and disk flowers. During the summer of 1950 I observed a pale-colored variant of this species growing in a prairie along a railroad in northern Missouri. Unlike the typical color form, the pale variant had the disk pale yellow with the disk flowers yellow-green or pale yellow. The pale yellow rays were shorter than those of ordinary *H. mollis*. Two colonies of the pale-colored form were found in the midst of the ordinary deeper yellow colored phase.

Two plants were transplanted to my wild flower garden in northern Illinois. These were studied during 1951 and the characters of the pale yellow color and short rays were found to persist. It, therefore, seems worthwhile to designate this as a new form.

Helianthus mollis Lam., forma **flavida** Steyermark, f. nov., a typo differt ligulis et disci floribus flavidis; ligulis brevioribus.—Prairie along railroad, route 36, 4.4 mi. northwest of western limit of Lentner, Shelby Co., Missouri, August 21, 1950, *Julian A. Steyermark, 70126*, type, in Herb. Chi. Nat. Hist. Mus.—Julian A. Steyermark, Chicago Natural History Museum and Missouri Botanical Garden.

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